Development and Testing of a Log Spiral of Revolution, Oriented Graphite Monochromator for XAFS

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We have developed a log spiral of revolution monochromator for detection of the fluorescence XAFS of dilute atomic species in the presence of competing undesired fluorescence or scatter. The device consists of a plexiglas log spiral of revolution shaped for Cr K alpha detection.

Materials and Methods : The monochromatized radiation is detected by an annular array of PIN diodes. A blocking shield insures that direct fluorescence from the sample is not recorded. The oriented graphite is deposited by a proprietary method by Optigraph in Russia. We tested the device by using alloys of Cr with V,Ti, and Mn. The device does not saturate, in contrast to multi-element energy dispersive detectors. Tests were carried out at the X-11A beam line of the NSLS, the focused X-16C line of the NSLS and the PNC-CAT line at the APS.

Results: We obtain excellent Cr XAFS for a 1 % Cr in 99% V sample despite the fact that the Cr XAFS is completely overwhelmed by V XAFS if a standard ion chamber is used[1]. A sample that concentrated in V will tend to saturate an energy dispersive detector. We can completely remove the Mn from the Cr XAFS for a sample of 80% Cr and 20% Mn by carefully tuning the sample position plane[1]. The device is surprisingly tunable, and we have removed diffraction peaks from both Cr and V edges in a Cr-V-Ti alloy of interest for possible fusion reactor wall applications[2]. The solid angle of our prototype device is 17% of 4 pi and the present resolution at the Cr edge is 260 eV. The brightness of quality, bulk highly oriented pyrolytic graphite (HOPG) at the energy of the Cu K_α line is about 50%.[3] We have perfomed diffraction experiments which show that the brightness of our HOPG is about half that value[2]. Both the resolution and solid angle could be improved by using a larger log spiral and a thinner HOPG covering[1,2]. The device is small, light, rugged, and can be aligned and collecting data within a few minutes of operation.

Conclusions: We believe the log spiral of revolution may have a niche as a detector for dilute species XAFS. The resolution is adequate for removing the fluorescence of neighboring transition metals from the desired signal, and the brightness and solid angle is good. The covering cost for the HOPG is sufficiently reasonable that one could make a series of the devices for covering the first row transition elements for about the cost of a multi-element, energy dispersive detector. A disadvantage is that one needs a focused beam for adequate intensity.

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